Engineering 2019 v1.1

IA2 sample marking scheme

Examination — short response (25%)

This sample has been compiled by the QCAA to model one possible approach to allocating marks in an examination. It matches the examination mark allocations as specified in the syllabus (~ 60% simple familiar, ~ 20% complex familiar and ~ 20% complex unfamiliar) and ensures that a balance of the objectives are assessed.

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. recognise and describe structural problems, engineering technology knowledge, and mechanics and materials science concepts and principles in relation to structures
2. symbolise and explain ideas and solutions in relation to structures
3. analyse structural problems and information in relation to structures
5. synthesise information and ideas to predict possible structural solutions.

Note: Objectives 4, 6, 7 and 8 are not assessed in this instrument.

Queensland Government
QCAA Queensland Curriculum & Assessment Authority
220465
For all Queensland schools

Instrument-specific marking guide (ISMG)

Criterion: Engineering knowledge and problem-solving

Assessment objectives

1. recognise and describe structural problems, engineering technology knowledge, and mechanics and materials science concepts and principles in relation to structures
2. symbolise and explain ideas and solutions in relation to structures
3. analyse structural problems and information in relation to structures
5. synthesise information and ideas to predict possible structural solutions

The student work has the following characteristics:	Cut-off	Marks
• across the full range of simple familiar, complex familiar and complex unfamiliar situations – accurate and discriminating recognition and discerning description of structural problems, knowledge, concepts and principles; adept symbolisation and discerning explanation of ideas and solutions; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to predict possible solutions.	> 96%	25
	> 93%	24
• in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations – accurate and discriminating recognition and discerning description of structural problems, knowledge, concepts and principles; adept symbolisation and discerning explanation of ideas and solutions; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to predict possible solutions.	> 89%	23
	> 86%	22
• in a comprehensive range of simple familiar situations, and in complex familiar and complex unfamiliar situations – accurate recognition and effective description of structural problems, knowledge, concepts and principles; methodical symbolisation and effective explanation of ideas and solutions; considered analysis of problems and information; logical synthesis of information and ideas to predict possible solutions.	> 82%	21
	> 78%	20
• in a range of simple familiar situations, and in complex familiar and complex unfamiliar situations – accurate recognition and effective description of structural problems, knowledge, concepts and principles; methodical symbolisation and effective explanation of ideas and solutions; considered analysis of problems and information; logical synthesis of information and ideas to predict possible solutions.	> 75%	19
	> 71%	18
• in a range of simple familiar situations and in complex familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 68%	17
	> 64%	16

The student work has the following characteristics:	Cut-off	Marks
• in a range of simple familiar situations and in some complex familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 60%	15
	> 57%	14
• in simple familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; variable symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 53%	13
	> 50%	12
• in simple familiar situations – variable recognition and superficial description of structural problems, knowledge, concepts and principles; variable symbolisation and superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to predict possible solutions.	> 46%	11
	> 42%	10
• in some simple familiar situations – variable recognition and superficial description of aspects of structural problems, knowledge, concepts and principles; superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to predict partial possible solutions.	> 37%	9
	> 33%	8
• in a limited range of simple familiar situations – variable recognition and superficial description of aspects of structural problems, knowledge, concepts and principles; superficial explanation of ideas and solutions; superficial analysis of aspects of problems and information; unclear combination of information and ideas.	> 28%	7
	> 24%	6
• disjointed recognition and statements about aspects of structural problems, knowledge, concepts and principles; identification of a change about ideas, solutions and information; unclear combination of information and ideas	> 19%	5
	> 14%	4
• statements about aspects of structural problems, knowledge, concepts and principles; statements about ideas, solutions and information; isolated and unclear combination of information and ideas	> 10%	3
	> 5%	2
• isolated and unclear statements about aspects of structural problems, knowledge, concepts and principles	> 0%	1
• does not satisfy any of the descriptors above.		0

Task

See the sample assessment instrument for Unit 3: Examination — short response (25%) (available on the QCAA Portal).

Sample marking scheme

Criterion	Marks allocated	Result
Engineering knowledge and problem-solving Assessment objective/s 1, 2, 3 and 5	25	25
Total	**25**	25

The annotations are written descriptions of the expected response for each question and are related to the assessment objectives.

Marking scheme symbols and abbreviations

The following marking scheme symbols and abbreviations should be used where possible.

Symbol or abbreviation	Meaning
✓	The preceding section of the expected response is worth 1 mark.
I	Separates acceptable alternative wordings
()	Terms in brackets are not necessary for the mark to be awarded.
underlined text	Underlined text must be included in the response for the mark to be awarded.
Accept converse.	Award the mark even if the answer is stated in its converse form, e.g. 'A comes before B' can be stated as 'B comes after A'.
Accept *min-max*	Award the mark for any numerical answer that falls within the specified range. e.g. Accept 1.5–1.9 means that any answer between 1.5 and 1.9 should be considered correct. This is used in items that involve a multi-step calculation where differences in rounding in the intermediate steps could result in slight differences in the final answer.
Allow for FT error	Allow for 'follow-through error'. Initial errors should not be penalised more than once. Marks should be awarded for subsequent steps that are correct.
Allow FT error for transcription only	FT error is only allowed if the student has written down information incorrectly but processed it correctly.
AND	Separates two parts that are both required for the mark to be awarded.
Correct d.p. required	The answer must be stated to the number of decimal places indicated in the item for the mark to be awarded.
Correct s.f. required	The answer must be stated to the correct number of significant figures for the mark to be awarded.
Max. # marks	The maximum number of marks that can be awarded for the item is indicated by #. This is used where the number of possible correct answers is larger than the mark value of the item.
OR	Separates acceptable alternative wordings
OWTTE	'Or words to that effect' This is used in questions where students are unlikely to use the exact wording given in the expected response to reinforce the convention that if the student's response has the same meaning as the expected response then the mark should be awarded.
Working not required	Evidence of working, reasoning or calculations is not required for the mark to be awarded.

Marking scheme

Note: ✓ = **1** mark

Section 1 — multiple choice, single word and sentence response items

recognise and describe engineering technology knowledge

Question 1 (1 mark)

B have a limited lifespan ✓

recognise and describe material science concepts and principles

Question 2 (1 mark)

C compressive and tensile strength ✓

recognise and describe mechanics concepts and principles

Question 3 (1 mark)

A normal to the supporting surface ✓

recognise and describe engineering technology knowledge

Question 4 (1 mark)

C predict prototype solution performance ✓

recognise and describe engineering technology knowledge

Question 5 (1 mark)

D evaluate and refine ideas and solutions ✓

recognise and describe engineering technology knowledge

Question 6 (1 mark)

explore OR exploring ✓

recognise and describe mechanics concepts and principles

Question 7 (2 marks)

strength ✓and stiffness ✓ OWTTE

Also accept tensile OR compressive strength ✓ and stiffness✓ OWTTE

recognise and describe materials science concepts and principles

Question 8 (1 mark)

ductility OR ductile ✓

recognise and describe materials science concepts and principles	**Question 9 (1 mark)** brittle OR brittleness ✓
recognise and describe material science concepts and principles	**Question 10 (1 mark)** Zinc ✓
recognise and describe material science concepts and principles	**Question 11 (2 marks)** oxidation OR chemical attack ✓ occurs without the presence of moisture OR water ✓ OWTTE
recognise and describe mechanics concepts and principles	**Question 12 (2 marks)** no effect on the length of the beam's neutral axis ✓✓ OWTTE
recognise and describe engineering technology knowledge synthesise information 1 mark for each section where a sub-discipline is recognised and information is synthesised to appropriately describe the scope of the selected sub-discipline. (The Engineering 2019 v1.1 general syllabus identifies many different civil engineering sub-disciplines that could be selected.)	**Question 13 (4 marks)** Coastal ✓ engineering The sub-discipline that deals with structures, such as canal developments, docks or wharves, or any type of development that occurs within the coastal zone near or at the shoreline. ✓ Water resource ✓ engineering The sub-discipline that deals with the planning, development, management and supply of water resources. Water resource engineers also calculate water inflows and removal in areas of structural development. ✓

Section 2 — short paragraph and calculation items

Question 14 (4 marks)

recognise and describe engineering technology knowledge,

analyse information

synthesise information

1 mark for accurately recognising and describing the life cycle of the material.

2 marks for considered analysis of the environmental implications of the raw material's growth and/or extraction.

In the domestic building industry, treated softwood is the primary building material. The life cycle implications of the use of treated softwood are examined in relation to growth, harvesting, manufacture, construction, use and demolition.✓ Softwoods are plantation grown and considered renewable. However, softwood plantations destroy natural environments and impact on local Indigenous flora and fauna populations. Machines strip branches and remove logs for milling, which damages soils and undergrowth leading to potential erosion and loss of habitat.✓✓ Softwood logs are milled to produce timber in various sizes. The logs are also used to manufacture laminated or plywood beams. These processes require large amounts of energy and chemicals in the form of glues and pesticides, which are residual and create hazards during construction, use and disposal. Off-cuts of treated softwood create on-site disposal hazards and worker health and safety concerns regarding handling and machining of chemical laden timber.✓

1 mark for logical synthesis of relevant information to provide an indication of the environmental implications of the raw materials manufacture and use

Question 15 (8 marks)

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

analyse structural problems and information

synthesise information and ideas

1 mark for accurately recognising and describing a relevant community and weather conditions.

3 marks for insightful structural analysis using materials science and mechanics concepts and principles.

The large dome structure provides an artificial environment that would suit a community that experiences extreme cold, snow fall and blizzards.✓ The structure is created using hexagonal frames which interconnect to create a self-supporting network that transfers the tensile and compressive forces applied to the structure to the foundation.✓ The dome shape is aerodynamic which would resist the strong wind forces experienced at the location.✓ Snow would also slide off the structure ✓ which means that less weight force is supported by the dome in blizzard conditions.✓ The membrane that covers the dome would need to be insulated and made from a strong polyethylene type material✓ Air could be pumped into the pillow-like membrane at a regulated temperature.✓ Light and any radiant heat can be channelled into the dome through the membrane to reduce the energy consumed by the community.✓

4 marks for logical and coherent synthesis of relevant, engineering technology knowledge, materials science and mechanics information to describe how the dome structure would benefit the selected community.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

symbolise and explain solutions to structural problems

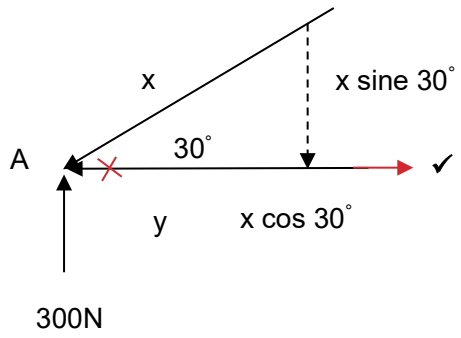
analyse structural problems and information

synthesise information and ideas

1 mark for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram.

Question 16 (4 marks)

$\sum F_V = 0$
$\sum F_H = 0$



Red arrow represents tension in member y when solved. ✓

$\sum F_y = 0 = 300 - x \sin 30°$

$\therefore x = \frac{300}{\sin 30°} = 600\text{N compression OR C}$ ✓

$\sum F_x = 0 = -x \cos 30° - y$

$\therefore \mathbf{y = -600 \times \cos 30° = -519.6N\ C \approx 520\ N\ tension}$ OR T ✓ ✓

2 marks — 1 mark for each logically synthesised working and correct answer to the force in members x and y. Allow for FT error.

1 mark for correctly recognising tension and compression for each answer.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

symbolise and explain solutions to structural problems

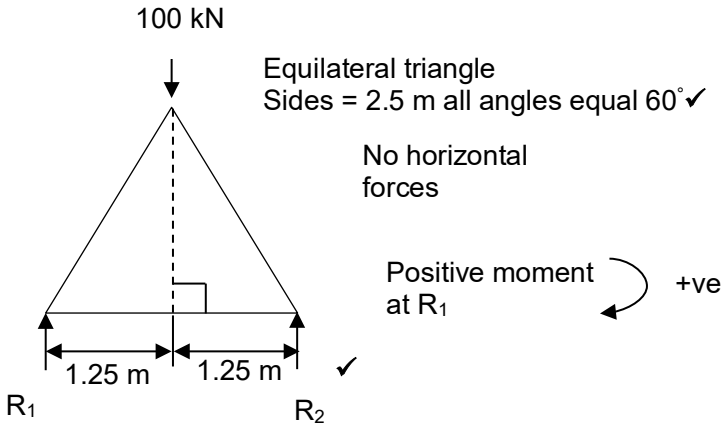
analyse structural problems and information

synthesise information and ideas

1 mark for recognising that the simple truss forms an equilateral triangle and therefore all included angles are 60° OR that the altitude, median, angle bisector, and perpendicular bisector are the same line.

1 mark for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram.

Question 17 (4 marks)



$\sum M = 0$

$\therefore 0 = 100 \times 1.25 - R_2 \times 2.5$

$0 = 125 - 2.5 \times R_2$

$R_2 = \frac{125}{2.5} = 50 \text{ kN} \uparrow$ ✓

$\sum F_y = 0 = R_1 - 100 + 50$

$\therefore R_1 = 100 - 50 = 50 \text{ kN} \uparrow$ ✓

2 marks — 1 mark for each logically synthesised working and answer to the reactions at R_1 and R_2.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

symbolise and explain solutions to structural problems

analyse structural problems and information

synthesise information and ideas

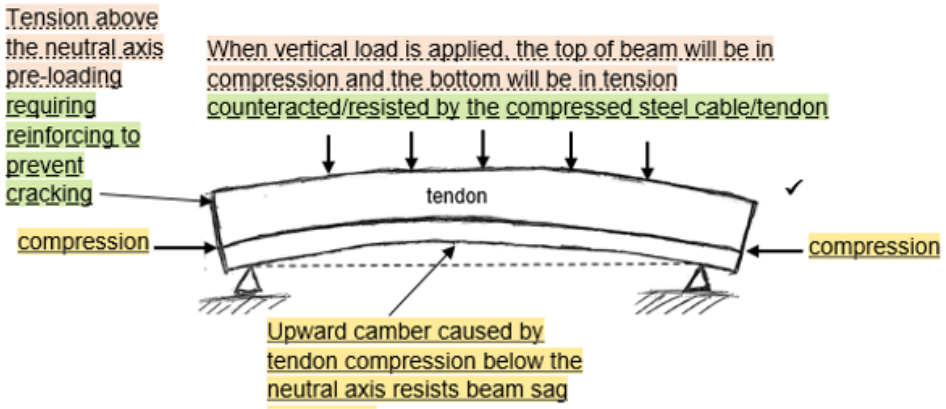
1 mark for recognising and describing how and why concrete beams are prestressed, including the properties of concrete OWTTE.

1 mark for insightful analysis of the prestressing process to accurately recognise the tensile force in the cable prior to concrete pour.

1 mark for insightful analysis to recognise the bending moment created in the beam due to compression of the cable after release of tension post concrete cure.

Question 18 (6 marks)

Precast concrete beams are prestressed to improve on their capacity to resist the tensile forces applied when under load. Concrete is extremely weak in tension but stronger in compression. The beam is cast into a mould that allows steel cables/tendons to be fixed at one end of the mould.✓ These cables have a large tensile force applied to them✓ by being stretched within their elastic limit before the concrete is poured.✓ The concrete is cured in the mould for a number of days or weeks depending on the initial compressive strength required. When cured, the tension applied to the tendons is released and they shorten in length resulting in the inclusion of compressive forces in the beam to resist applied tensile forces when in use. The cables placed close to the beams base create a bending moment in the beam✓ causing the beam to camber upward at its centre to resist deflection under applied vertical loads during working conditions.✓



2 marks for logical and coherent synthesis of relevant mechanics information to describe how the forces are realised within the beam to explain why concrete beams

1 mark for adept symbolisation of the beam to appropriately explain the forces present in the prestressed concrete beam after cure.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

symbolise and explain solutions to structural problems

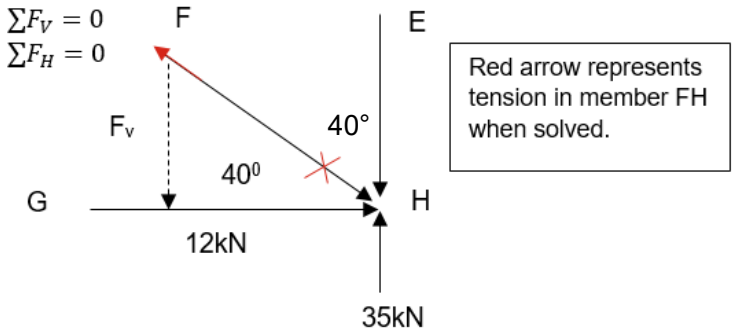
analyse structural problems and information

synthesise information and ideas

1 mark for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram.

3 marks for the logically synthesised working and correct answer. Allow for FT error.

Question 19 (4 marks)



$\therefore \sum F_H = 0 = 12 + FH\cos 40°$ ✓

$-12 = FH\cos 40°$

$\frac{-12}{\cos 40°} = FH$

$\therefore \mathbf{FH = -15.7\ kN\ C \approx 16\ kN\ tension\ OR}$ ✓

$\therefore \sum \mathbf{F_V = 0 = 35 + 15.7 \sin 40° - EH}$

$\mathbf{0 = 45 - EH}$

$\mathbf{EH = 45\ kN\ compression\ OR}$ ✓ ✓

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

analyse structural problems and information

synthesise information and ideas

1 mark for considered analysis of the question to recognise that a bending moment about A *or* B is required.

Question 20 (4 marks)

$\sum M_A = 0$ ✓

$\therefore 0 = 8 \times 2 + 4 \times 4 - R_2 \times 5$

$0 = 32 - R_2 \times 5$

$R_2 = \frac{32}{5} = 6.4 \text{ kN} \uparrow$ ✓

$\sum F_y = 0 = R_1 - 8 - 4 + R_2$

$0 = R_1 - 12 + 6.4$

$0 = R_1 - 5.6$

$\therefore R_1 = 5.6 \text{ kN} \uparrow$ ✓ ✓

3 marks total for logically synthesised working and the answer to the reactions at R_1 and R_2. Allow for FT error.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

analyse structural problems and information

synthesise information and ideas

1 mark for considered analysis of the question to recognise that the force vector acting at 45° down to the left requires trigonometry to calculate the vertical loading on the beam.

Question 21 (4 marks)

$\sum M_O = 0$ ↻ +ve

$\sum M_O = 0 = -1000 \times 9 + 600 \times x + 1000 \sin 45° \times (7 + x)$ ✓

$= -9000 + 600x + 707.1 \times 7 + 707.1x$

$= -4050.3 + 1307.1x$

$4050.3 = 1307.1x$

$\therefore x = \frac{4050.3}{1307.1} = 3.1 \text{ m}$ ✓ ✓

$\therefore$ total length of the beam $= 9 + 3.1 + 7 = 19.1 \text{ m} \approx 19 \text{ m}$ ✓

3 marks for logical synthesis of the working to solve for X and determine the total length of the beam. Allow for FT error.

symbolise and explain solutions to structural problems

analyse structural problems and information

synthesise information and ideas

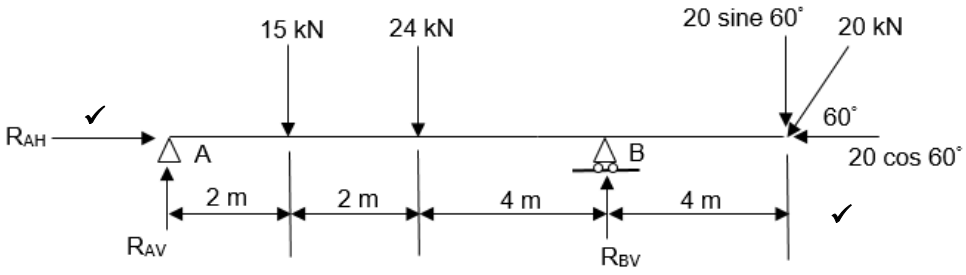
1 mark for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram.

1 mark for insightful analysis of the problem to recognise the horizontal reaction at support A and the UDL of 24 kN at the midpoint of AB.

Question 22 (5 marks)

Uniformly distributed load over 8 m of 3 kN/m

$F = 3\ \text{kNm} \times 8\ \text{m} = 24\ \text{kN}$



$\sum F_H = 0 = R_{AH} - 20\cos 60°$

→ +ve

$\therefore R_{AH} = 20\cos 60° = 10\ \text{kN} \rightarrow$ ✓

$\sum M_A = 0$ ↻ +ve

$\sum M_A = 0 = 15 \times 2 + 24 \times 4 - R_{BV} \times 8 + 20\sin 60° \times 12$

$= 333.85 - 8R_{BV}$

$R_{BV} = \frac{333.85}{8} = 41.7\ \text{kN} \uparrow$ ✓

$\sum F_A = 0 = R_{AV} - 15 - 24 + R_{BV} - 20\sin 60°$

↑ +ve

$= R_{AV} - 15 - 24 + 41.7 - 20\sin 60°$

$R_{AV} = -39 + 41.7 - 20\sin 60°$

$R_{AV} = -39 + 41.7 - 20\sin 60° = 14.6\ \text{kN} \uparrow$ ✓

1 mark for logical synthesis of the working to correctly solve for R_{AH}. Allow for FT error.

1 mark for logical synthesis of the working to correctly solve for the vertical reaction at support B. Allow for FT error.

1 mark for logical synthesis of the working to correctly solve for the vertical reaction at support A. Allow for FT error.

recognise and describe engineering technology knowledge, and mechanics and materials science concepts and principles

symbolise and explain solutions to structural problems

analyse structural problems and information

synthesise information and ideas

2 marks for considered analysis of the question to adeptly and correctly symbolise the shear force and bending moment diagrams recognising an appropriate scale. Allow for FT error.

2 marks for logical synthesis of the working to correctly solve for the vertical reactions at the supports and bending moments. Allow for FT error.

Question 23 (4 marks)

without mass.

$\sum M_A = 0$ +ve

$\therefore 0 = 20\times3 + 50\times7 - R_B\times10$

$0 = 410 - R_B\times10$

$R_B = \frac{410}{10} = 41\text{kN}$

$\sum F_y = 0 = R_A - 20 - 50 + R_2$

$0 = R_A - 70 + 41$

$0 = R_A - 29$

$\therefore R_A = 29\text{kN}$ +ve ✓

Shear force diagram scale:
1cm =1m
1cm = 10kN

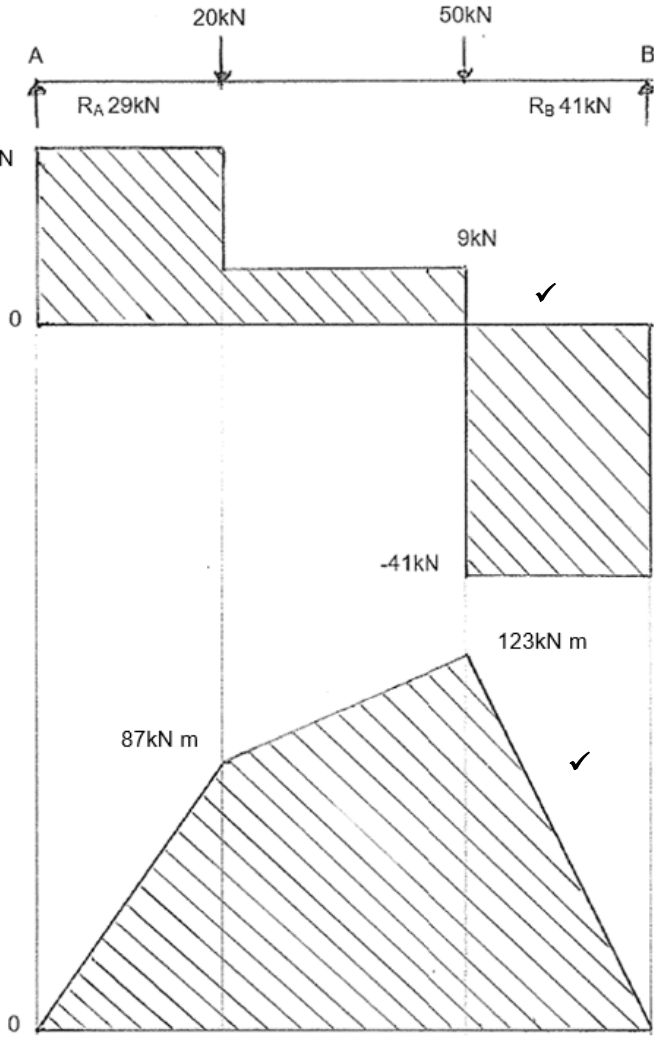
Moment = Fd

$M_1 = 29\times3 = 87\text{kN m}$

$M_2 = 9\times4 + M_1 = 123\text{kN m}$

$M_3 = -41\times3 = -123\text{kN m}$ ✓

Bending moment diagram scale:
1cm = 1m
1cm = 20kN m



symbolise and explain solutions to structural problems

analyse structural problems and information

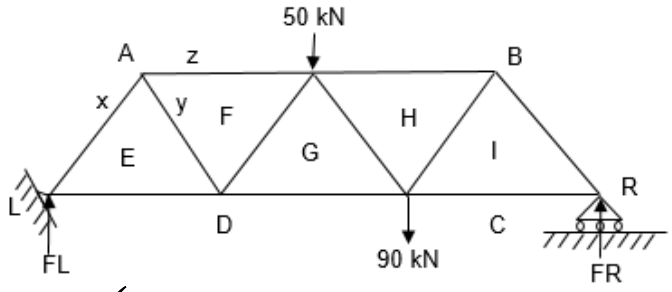
synthesise information and ideas

1 mark for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram and explain that all internal angles are almost equal to 60°.

5 marks for logical synthesis of the working to correctly solve the force in members X, Y and Z. Allow for FT error.

Either the method of joints OR method of sections analysis can be used.

Question 24 (6 marks)



- all internal angles $\approx 60^{\circ}$ ✓
- assume all members are in compression

$\sum M_L = 0$ +ve

$\sum M_L = 0 = 50\times5.25 + 90\times7 - FR\times10.5$

$10.5FR = 892.5$

$FR = \frac{892.5}{10.5} = 85\text{ kN}$ ✓

$\sum M_R = 0$ +ve

$\sum M_R = 0 = -90\times3.5 - 50\times5.25 + FL\times10.5$

$10.5FL = -577.5$

$FL = \frac{-577.5}{10.5} = 55\text{ kN}$ ✓

Joint AED

$\sum F_y = 0 = 55 - x\sin 60^{\circ}$

$x\sin 60^{\circ} = 55$

$x = \frac{55}{\sin 60^{\circ}} \approx 63.5\text{ kN compression}$ ✓

Joint AFB

$\sum F_y = 0 = 63.5\times\sin 60^{\circ} + y\sin 60^{\circ}$

$-y\sin 60^{\circ} = 55$

$-y = \frac{55}{\sin 60^{\circ}} \approx 63.5\text{ kN}$

$\therefore y = -63.5\text{ kN compression}$

$\therefore y = 63.5\text{ kN tension}$ ✓

$\sum F_x = 0 = 63.5\times\cos 60^{\circ} + 63.5\times\cos 60^{\circ} - z$

$\sum F_x = 0 = 63.5 - z$

$z = 63.5\text{ kN compression}$ ✓

$\therefore$ force in X $= 63.5\text{ kN compression}$

force in Y $= 63.5\text{ kN tension}$

force in Z $= 63.5\text{ kN compression}$

symbolise and explain solutions to structural problems

analyse structural problems and information

synthesise information and ideas

2 marks for insightful analysis of the problem to synthesise information to state relevant assumptions.

1 mark for logical synthesis of the working to correctly solve the backpack and Jess weight forces.

2 marks for considered analysis of the question to adeptly symbolise and explain the problem with an accurate free-body diagram for each scenario.

1 mark for logical synthesis of the working to correctly solve F_TX in scenario 1. Allow for FT error.

1 mark for logical synthesis of the working to correctly solve FTX in scenario 2. Allow for FT error.

1 mark for logical synthesis of the working to correctly substitute the value of F_TX from scenario 1 into scenario 2 and solve F_T and Tom's mass. Allow for FT error.

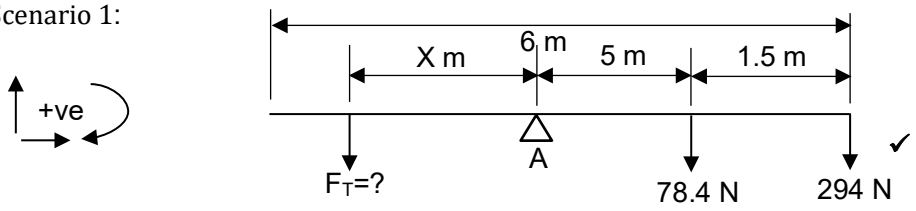
Question 25 (9 marks)

Assumptions

- The seesaw is in equilibrium in each scenario.
- Pivot point A is at the mid-point of the 6 m long seesaw.
- The mass of the seesaw will not influence the outcome as it is in balance — that is equal mass either side of the pivot point, which includes the tyres, brackets and any fixings.
- Gravity = 9.8 ms^{-2}
- Let F_T be the weight force of Tom. ✓ ✓

Weight force of the 8 kg backpack: $F = 8 \times 9.8 = 78.4$ N
Weight force of Jess: $F = 30 \times 9.8 = 294$ N ✓

Scenario 1:

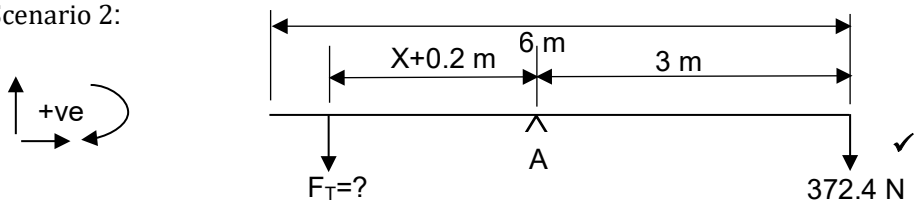


✓

$\sum M_A = 0$ +ve

$\sum M_A = 0 = -F_T X + 78.4 \times 1.5 + 294 \times 3$
$0 = -F_T X + 78.4 \times 1.5 + 294 \times 3$
$F_T X = 999.6$ N ✓

Scenario 2:



✓

$\sum M_A = 0$ +ve

$\sum M_A = 0 = -F_T(X + 0.2) + 372.4 \times 3$
$0 = -F_T X + -F_T \times 0.2 + 1117.2$
$F_T X = -F_T \times 0.2 + 1117.2$ ✓

Substitute scenario 1 into scenario 2:
$999.6 = -F_T \times 0.2 + 1117.2$
$-117.6 = -F_T \times 0.2$
$F_T = \frac{117.6}{0.2} = 588$ N ∴ The mass of Tom is $\frac{588}{9.8} = 60$ kg ✓

Substitute F_T into scenario 1
$588X = 999.6$
$X = \frac{999.6}{588} = 1.7$ m $= 1700$ mm ✓
∴ the distance X from the seesaw pivot is 1.7 m OR 1700 mm

1 mark for logical synthesis of the working to substitute the value of F_T into scenario 1 to accurately calculate the value of X. Allow for FT error.